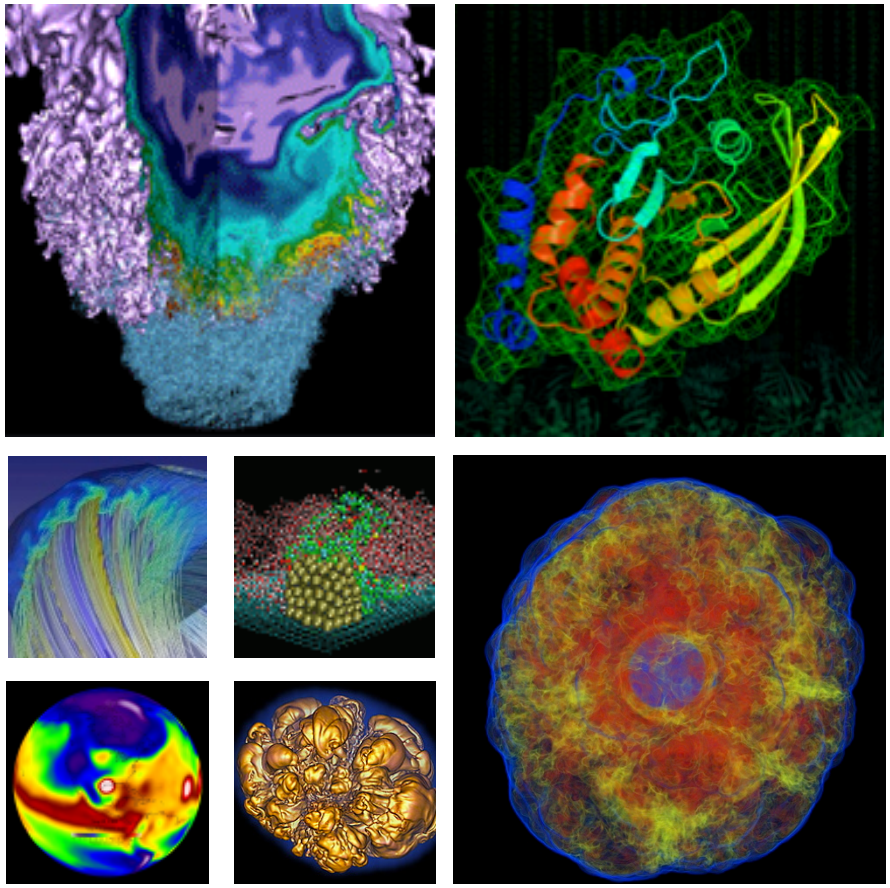
Introduction to Archival Storage at NERSC



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Storage Systems Group

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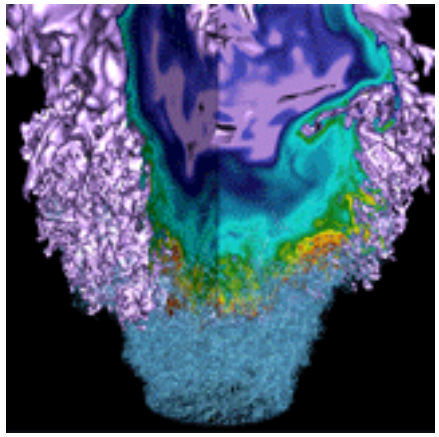
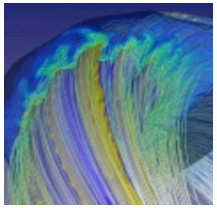
Agenda

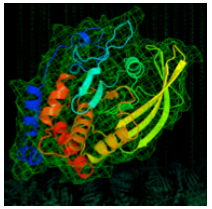
- **Objectives**
  - Describe the role of archival storage in a tiered storage strategy
  - Log into the NERSC archive
  - Store and retrieve files from the archive
  - Avoid common problems
- **Archive Basics**
  - What is an archive?
  - Why should I use one?
  - Features of the NERSC archive
- **Using the NERSC Archive**

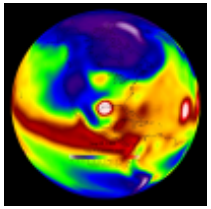
  Note: *Unix/Linux command-line familiarity required*
  - How to log in
  - Storing and retrieving files with HSI
  - Storing and retrieving directories with HTAR
  - Avoiding common mistakes
- **Questions, Problems, Further Reading**
- **Hands-on Examples**

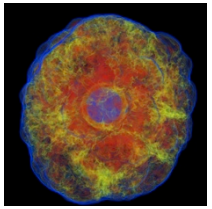
Archive Basics

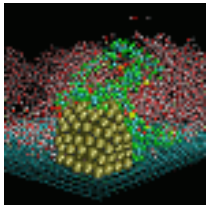










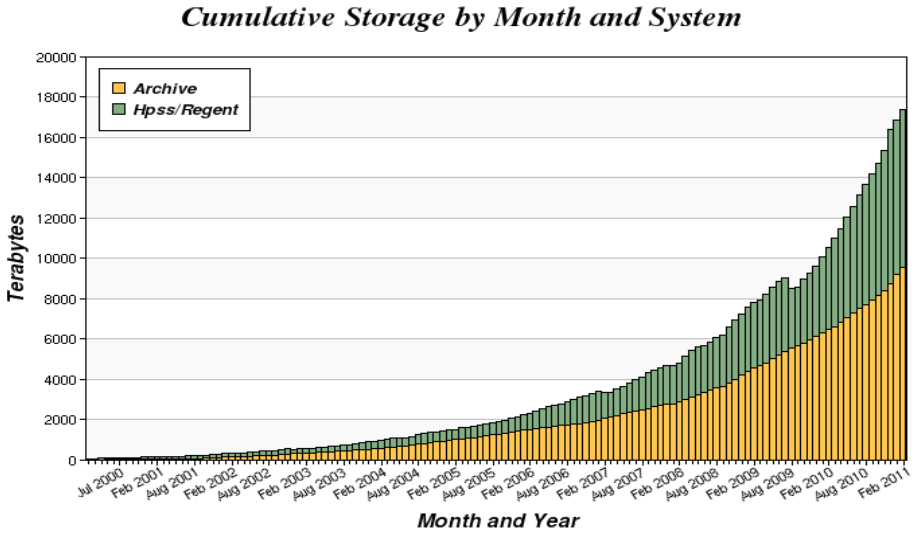


What is an archive?

- **Long-term storage of permanent records and information**
  - Often data that is no longer modified or regularly accessed
  - Storage time frame is indefinite or as long as possible
  - Archive data typically has, or may have, long-term value to the organization
- **An archive is not a backup**
  - A backup is a copy of production data
  - Value and retention of backup data is short-term
- **A backup is a copy of data. An archive *is* the data.**

Why should I use an archive?

- **Data growth is exponential**



- **File system space is finite**
  - 80% of stored data is never accessed after 90 days
  - The cost of storing infrequently accessed data on spinning disk is prohibitive
  - Important, but less frequently accessed data should be stored in an archive to free faster disk for processing workload

Why should I use an archive (continued)?

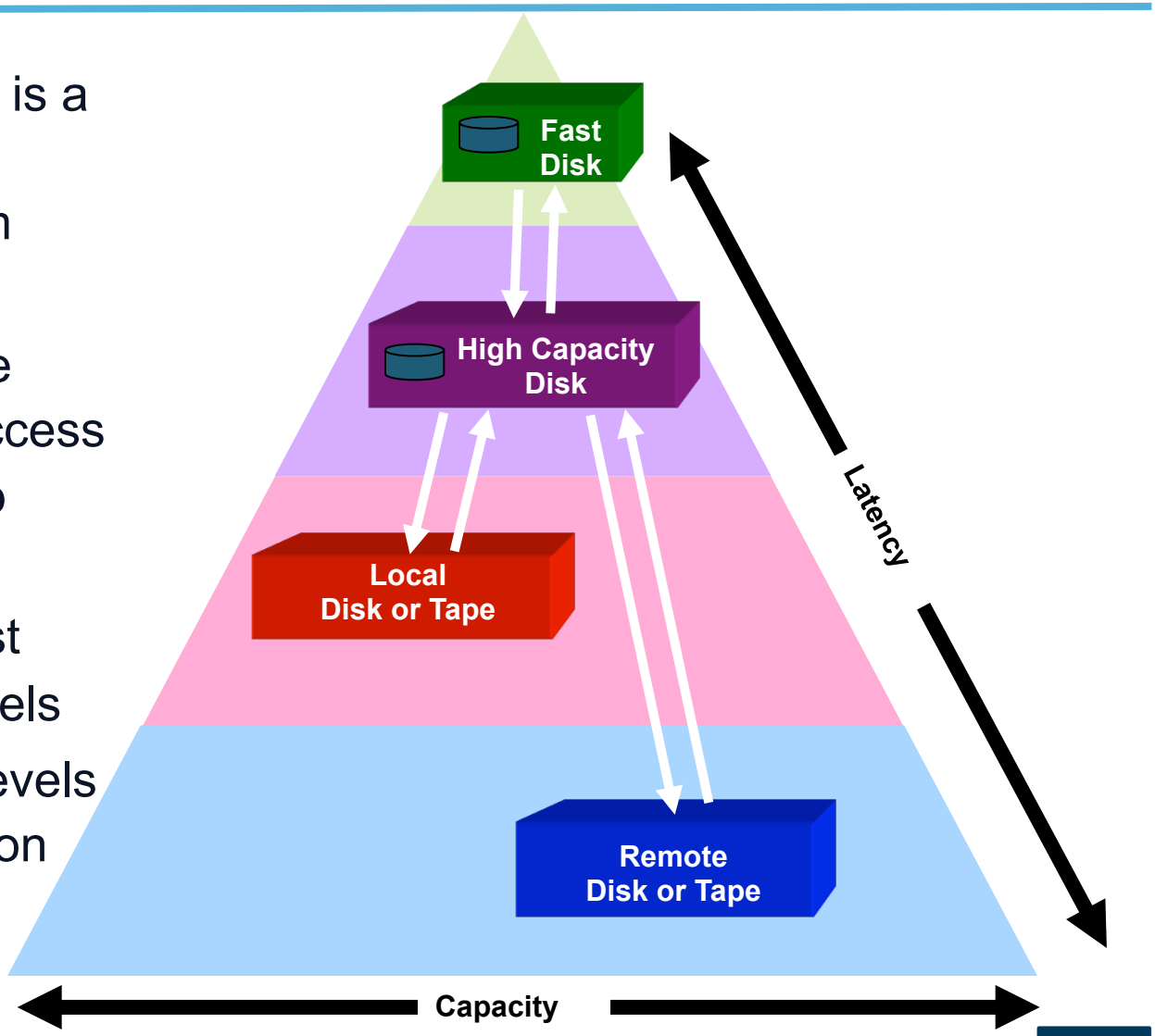
- **Archives are an important component of a tiered data management strategy**
  - Align value and access patterns of data with media on which it is stored:
    - Flash: IO intensive workloads
    - Disk: primary storage
    - Tape: backup, long-term storage (archive)
- **Tape still the lowest cost/GB**
  - 30 year shelf life
  - Energy savings over disk
  - Lower admin costs
  - Lower bit error rate (BER)
- **Typical use cases at NERSC include:**
  - Long-term storage of very large raw data sets
    - Good for incremental processing
  - Long-term storage of result/processed data
  - Backups (e.g. global scratch purges)

Features of the NERSC archive

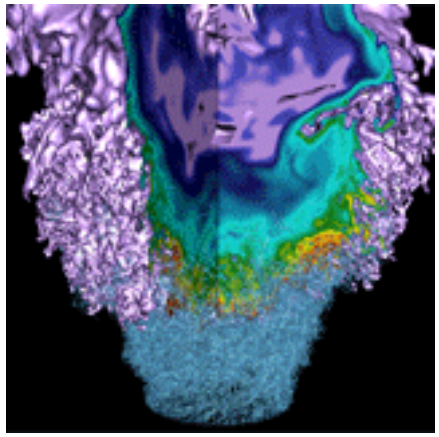
- **NERSC implements an "active archive"**
  - NERSC archive supports parallel high-speed transfer and fast data access
    - Data is transferred over parallel connections to the NERSC internal 10Gb network
    - Access to first byte in seconds or minutes as opposed to hours or days
    - The system is architected and optimized for ingest
- **The archive uses tiered storage internally to facilitate high speed data access**
  - Initial data ingest to high-performance FC disk cache
  - Data migrated to enterprise tape system and managed by HSM software (HPSS) based on age and usage
- **The NERSC archive is a shared multi-user system**
  - Shared resource, no batch system. Inefficient use affects others.
  - Session limits are enforced

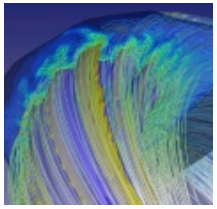
Features of the NERSC archive, continued

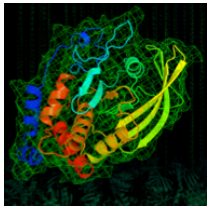
- The NERSC archive is a Hierarchical Storage Management system (HSM)
- Highest performance requirements and access characteristics at top level
- Lowest cost, greatest capacity at lower levels
- Migration between levels is automatic, based on policies

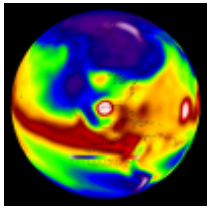


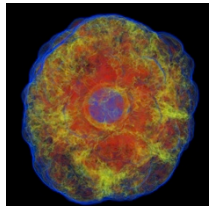
Using the NERSC Archive

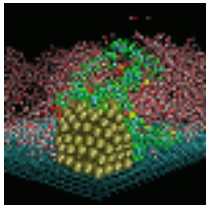












How to Log In

- **The NERSC archive uses an encrypted key for authentication**
  - Key placed in ~/.netrc file at the top level of the user's home directory on the compute platform
  - All NERSC HPSS clients use the same .netrc file
  - The key is IP specific. Must generate a new key for use outside the NERSC network.
- **Archive keys can be generated in two ways**
  - Automatic: NERSC auth service
    - Log into any NERSC compute platform using ssh
    - Type "hsi"
    - Enter NERSC password
  - Manual: https://nim.nersc.gov/ web site
    - Under "Actions" drop down, select "Generate HPSS Token"
    - Copy/paste content into ~/.netrc
    - chmod 600 ~/.netrc

Storing and Retrieving Files with HSI

- **HSI provides a Unix-like command line interface for navigating archive files and directories**
  - Standard Unix commands such as *ls*, *mkdir*, *mv*, *rm*, *chown*, *chmod*, *find*, etc. are supported
- **FTP-like interface for storing and retrieving files from the archive (put/get)**
  - **Store from file system to archive:**

    -bash-3.2$ **hsi**
    A:/home/n/nickb-> **put myfile**
    put 'myfile' : '/home/n/nickb/myfile' (2097152 bytes, 31445.8 KBS (cos=4))
  - **Retrieve file from archive to file system:**

    A:/home/n/nickb-> **get myfile**
    get 'myfile' : '/home/n/nickb/myfile' (2010/12/19 10:26:49 2097152 bytes, 46436.2 KBS)
  - **Full pathname or rename file during transfer:**

    A:/home/n/nickb-> **put local_file : hpss_file**
    A:/home/n/nickb-> **get local_file : hpss_file**

Storing and Retrieving Directories with HTAR

- **HTAR stores a Unix tar-compatible bundle of files (aggregate) in the archive**
  - Traverses subdirectories like tar
  - No local staging space required--aggregate stored directly into the archive
- **Recommended utility for storing small files**
- **Some limitations**
  - 5M member files
  - 64GB max member file size
  - 155/100 path/filename character limitation
  - Max archive file size* currently 10TB
- **Syntax: *htar [options] <archive file> <local file|dir>***
  - **Store**

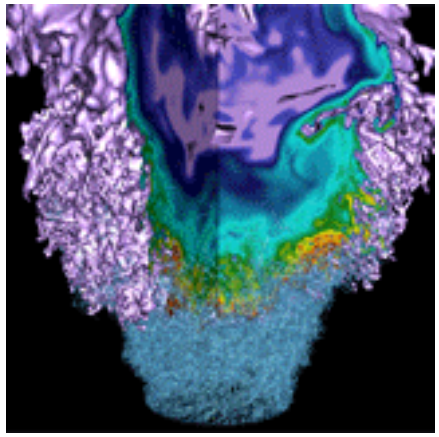
    ```
    -bash-3.2$ htar –cvf /home/n/nickb/mydir.tar ./mydir
    ```
  - **List**

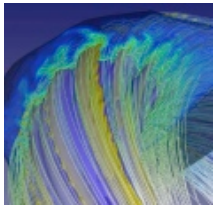
    ```
    -bash-3.2$ htar –tvf /home/n/nickb/mydir.tar
    ```
  - **Retrieve**

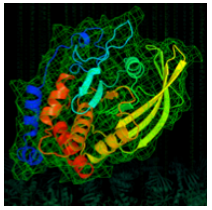
    ```
    -bash-3.2$ htar –xvf /home/n/nickb/mydir.tar [file…]
    ```

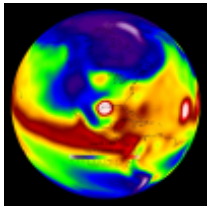
* By configuration, not an HPSS limitation

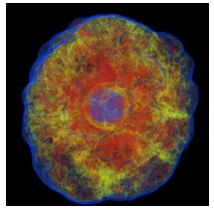
Avoiding Common Mistakes

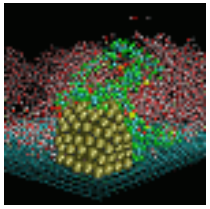












Small Files

- **Tape storage systems do not work well with large numbers of small files**
  - Tape is sequential media—tapes must be mounted in drives and positioned to specific locations for IO to occur
- **Mounting and positioning tapes are the slowest system activities**
  - Small file retrieval incurs delays due to high volume of tape mounts and tape positioning
  - Small files stored periodically over long periods of time can be written to hundreds of tapes—especially problematic for retrieval
- **Use HTAR when possible to optimize small file storage and retrieval**
- **Recommend file sizes in the 10s – 100s of GB**

Large Directories

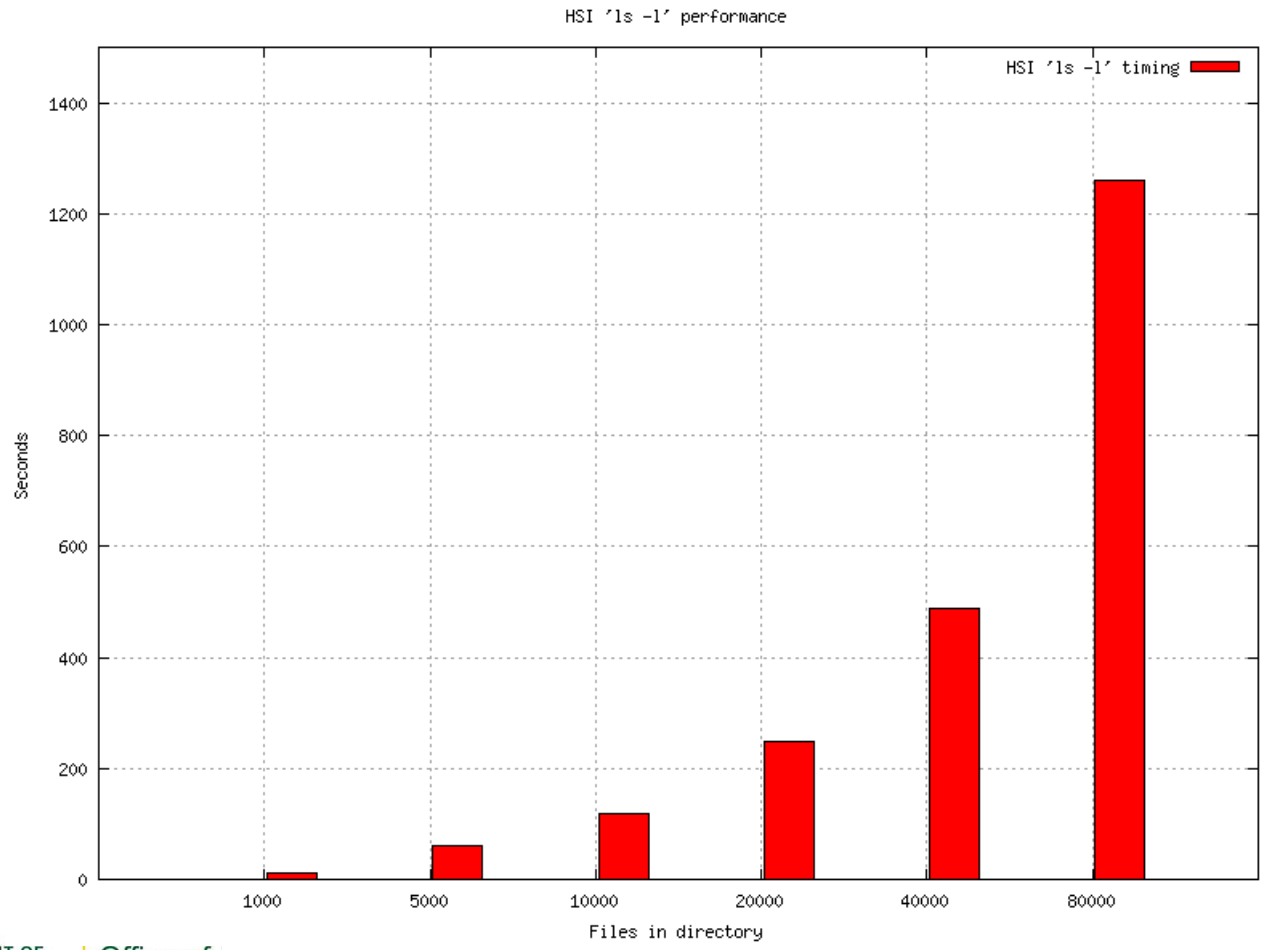
- **Each HPSS system is backed by a single metadata server**
  - Metadata is stored in a single SQL database instance
  - Every user interaction causes database activity
- **Metadata-intensive operations incur delays**
  - Recursive operations such as "*chown –R ./**" may take longer than expected
  - Directories containing more than a few thousand files may become difficult to work with interactively

```
-bash-3.2$ time hsi –q 'ls –l /home/n/nickb/tmp/testing/80k-files/' > /dev/null 2>&1

real 20m59.374s
user   0m7.156s
sys    0m7.548s
```

Large Directories, continued

- **hsi "*ls –l*" exponential delay:**



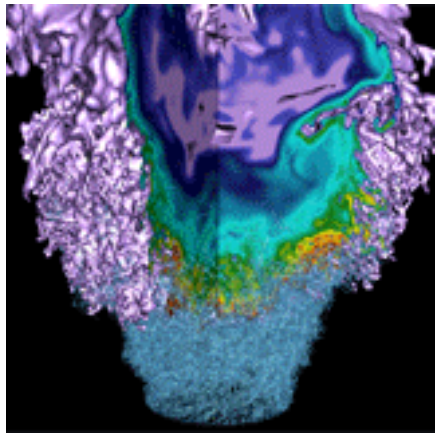
Long-running Transfers

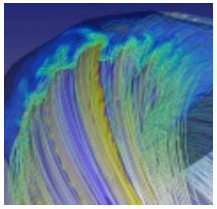
- **Failure prone for a variety of reasons**
  - Transient network issues, planned/unplanned maintenance, etc.
- **Many clients do not have capability to resume interrupted transfers**
- **Can affect archive internal data management (migration) performance**
- **Recommend keeping transfers to 24hrs or less if possible**

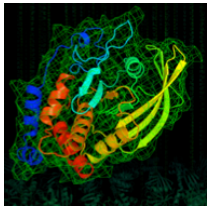
Session Limits

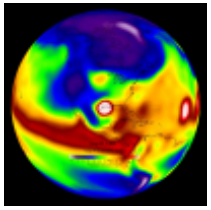
- 15 concurrent session/user enforced
- Can be administratively reduced if a user is negatively affecting system usability for others

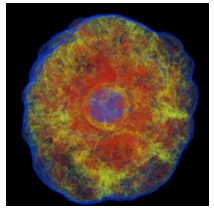
Questions, Problems, Further Reading

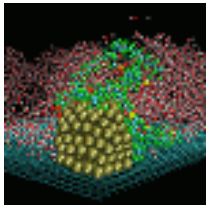












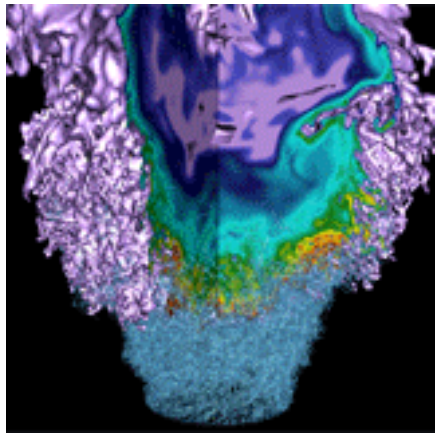
Asking Questions, Reporting Problems

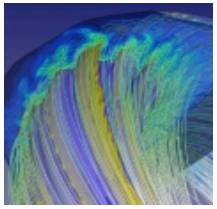
- **Contact NERSC Consulting**
  - Toll-free 800-666-3772
  - 510-486-8611, #3
  - Email *consult@nersc.gov*.

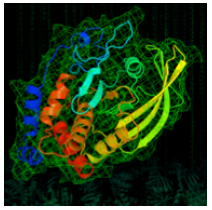
Further Reading

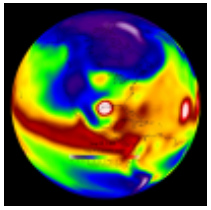
- **NERSC Website**
  - *http://www.nersc.gov/users/data-and-networking/hpss/*
- **HSI and HTAR man pages are installed on NERSC compute platforms**
- **Gleicher Enterprises Online Documentation (HSI, HTAR)**
  - *http://www.mgleicher.us/index.html/hsi/*
  - *http://www.mgleicher.us/index.html/htar/*
- **"*HSI Best Practices for NERSC Users,*" LBNL Report #LBNL-4745E**
  - *http://www.nersc.gov/assets/pubs_presos/HSIBestPractices-Balthaser-Hazen-2011-06-09.pdf*

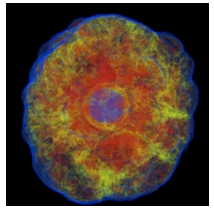
Hands-on Examples

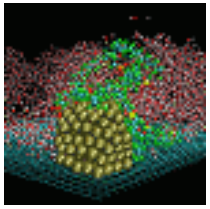












Logging into archive: Hands-on

- **Using ssh, log into any NERSC compute platform**

```
-bash-3.2$ ssh dtn01.nersc.gov
```

- **Start HPSS storage client "hsi"**

```
-bash-3.2$ hsi
```

- **Enter NERSC password at prompt (first time only)**

```
Generating .netrc entry...
nickb@auth2.nersc.gov's password:
```

- **You should now be logged into your archive home directory**

```
Username: nickb  UID: 33065  Acct: 33065(33065) Copies: 1 Firewall:
off [hsi.3.4.5 Wed Jul 6 16:14:55 PDT 2011][V3.4.5_2010_01_27.01]
A:/home/n/nickb-> quit
```

- **Subsequent logins are now automated**

Using HSI: Hands-on

- **Using ssh, log into any NERSC compute platform**

```
-bash-3.2$ ssh dtn01.nersc.gov
```

- **Create a file in your home directory**

```
-bash-3.2$ echo foo > abc.txt
```

- **Start HPSS storage client "hsi"**

```
-bash-3.2$ hsi
```

- **Store file in archive**

```
A:/home/n/nickb-> put abc.txt
```

- **Retrieve file and rename**

```
A:/home/n/nickb-> get abc_1.txt : abc.txt
A:/home/n/nickb-> quit
```

- **Compare files***

```
-bash-3.2$ sha1sum abc.txt abc_1.txt
f1d2d2f924e986ac86fdf7b36c94bcdf32beec15  abc.txt
f1d2d2f924e986ac86fdf7b36c94bcdf32beec15  abc_1.txt
```

* **Note**: checksums supported in the next HSI release with: 'hsi 'put *-c on* local_file : remote_file'

Using HTAR: Hands-on

- **Using ssh, log into any NERSC compute platform**
  ```
  -bash-3.2$ ssh dtn01.nersc.gov
  ```
- **Create a subdirectory in your home directory**
  ```
  -bash-3.2$ mkdir mydir
  ```
- **Create a few files in the subdirectory**
  ```
  -bash-3.2$ echo foo > ./mydir/a.txt
  -bash-3.2$ echo bar > ./mydir/b.txt
  ```
- **Store subdirectory in archive as "mydir.tar" with HTAR**
  ```
  -bash-3.2$ htar –cvf mydir.tar ./mydir
  ```
- **List newly created aggregate in archive**
  ```
  -bash-3.2$ htar –tvf mydir.tar
  ```
- **Remove local directory and contents**
  ```
  -bash-3.2$ rm –rf ./mydir
  ```
- **Extract directory and files from archive**
  ```
  -bash-3.2$ htar –xvf mydir.tar
  ```

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Section Title